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THE KNOCK-LIMITED PERFORMANCE OF SEVERAL FUELS BLENDED WITH S-2 REFERENCE FUEL

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WASHINGTON

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RESTRICTED BULLETIN

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INTRODUCTION

Tests were made at the Cleveland laboratory of the NACA during October 1943 to determine the knock-limited performance of blends containing 80 percent of S-2 reference fuel and 20 percent of several exploratory fuels. The sole criterion for the selection of the fuels for this program was that the freezing and boiling points were within the desirable range for aviation fuels.

The knock-limited performance of each blend was compared with the knock-limited performance of S-2 reference fuel.

APPARATUS AND TEST PROCEDURE

The following exploratory fuels in a concentration of 20 percent were combined with 80 percent of S-2 reference fuel: butyl acetate, sec-butyl acetate, isopropyl acetate, sec-butyl alcohol, tert-butyl alcohol, isopropyl alcohol, cyclohexanol, methylcyclohexanol, isobutylcarbinol, sec-butylcarbinol, triethyl borate, and dimethylfuran.

The tests were conducted on a high-speed, supercharged CFR engine coupled to a 25-horsepower, alternating-current, cradle-type dynamometer. The engine was equipped with an aluminum piston, a shrouded intake valve, a sodium-cooled exhaust valve, and a cylinder with four spark-plug holes. Knock was detected by a cathode-ray oscilloscope in conjunction with a magnetostriction pickup unit. Champion RJ-11 spark plugs were used throughout the tests. Because the engine was equipped with two independent fuel systems, less than 3500 milliliters of the blended fuel (700 ml of which was exploratory component) was required to determine its knock-limited performance over the normal range of fuel-air ratios.

The following engine conditions were maintained constant throughout the tests:

Inlet-air temperature, °F	250
Coolant temperature, °F	250
Oil temperature, °F	150
Spark advance, degrees B.T.C.	20
Engine speed, rpm	1800
Compression ratio	7.0

In each case a test of the blended fuel and a test of the S-2 reference fuel were made on the same day. Because the program was of short duration and because the daily S-2 reference curves were reproducible, an average reference curve was drawn using the data from the several tests.

RESULTS AND DISCUSSION

Figure 1 shows the comparison of the knock-limited performance of the exploratory fuels with S-2 reference fuel. Table I places the knock-limited power on a relative basis for the fuels at fuel-air ratios of 0.070, 0.0975, and 0.125.

Isopropyl acetate gave the best results of all the fuels tested. When blended with S-2 reference fuel, it proved most valuable in raising the knock-limited power near the stoichiometric-mixture ratio. In the range of fuel-air ratios from 0.10 to 0.12, however, no improvement was experienced with this fuel. tert-Butyl alcohol was the only other fuel that gave an improvement in the knock-limited lean-mixture performance.

The addition of sec-butyl acetate, isopropyl acetate, sec-butyl alcohol, tert-butyl alcohol, or isopropyl alcohol to S-2 reference fuel slightly increased the knock-limited power in the very rich-mixture region; sec-butyl acetate increased the knock-limited power of S-2 reference fuel 8 percent at a fuel-air ratio of 0.125.

The only fuels materially raising the indicated specific fuel consumption at rich mixtures were triethyl borate and isopropyl alcohol.

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TABLE I

THE RELATIVE POWER OUTPUTS OBTAINED WITH SEVERAL EXPLORATORY-FUEL BLENDS AS COMPARED WITH S-2 REFERENCE FUEL

Fuel (80 percent S-2 reference fuel plus 20 percent of the following components:)	Relative-power ratio $= \frac{\text{imep (exploratory fuel blend)}}{\text{imep (S-2 reference fuel)}}$		
	Fuel-air ratio		
	0.070	0.0975	0.125
S-2 reference fuel	1.00	1.00	1.00
Butyl acetate	.97	.97	.97
sec-Butyl acetate	.99	.95	1.08
Isopropyl acetate	1.16	1.02	1.03
sec-Butyl alcohol	.99	.93	1.02
tert-Butyl alcohol	1.08	.99	1.05
Isopropyl alcohol	.94	.87	1.03
Cyclohexanol	.85	.77	.87
Methylcyclohexanol	.85	.77	.87
Isobutylcarbinol	.93	.89	.94
sec-Butyl carbinol	.92	.85	.98
Triethyl borate	.88	.74	.81
Dimethylfuran	.92	.80	.93

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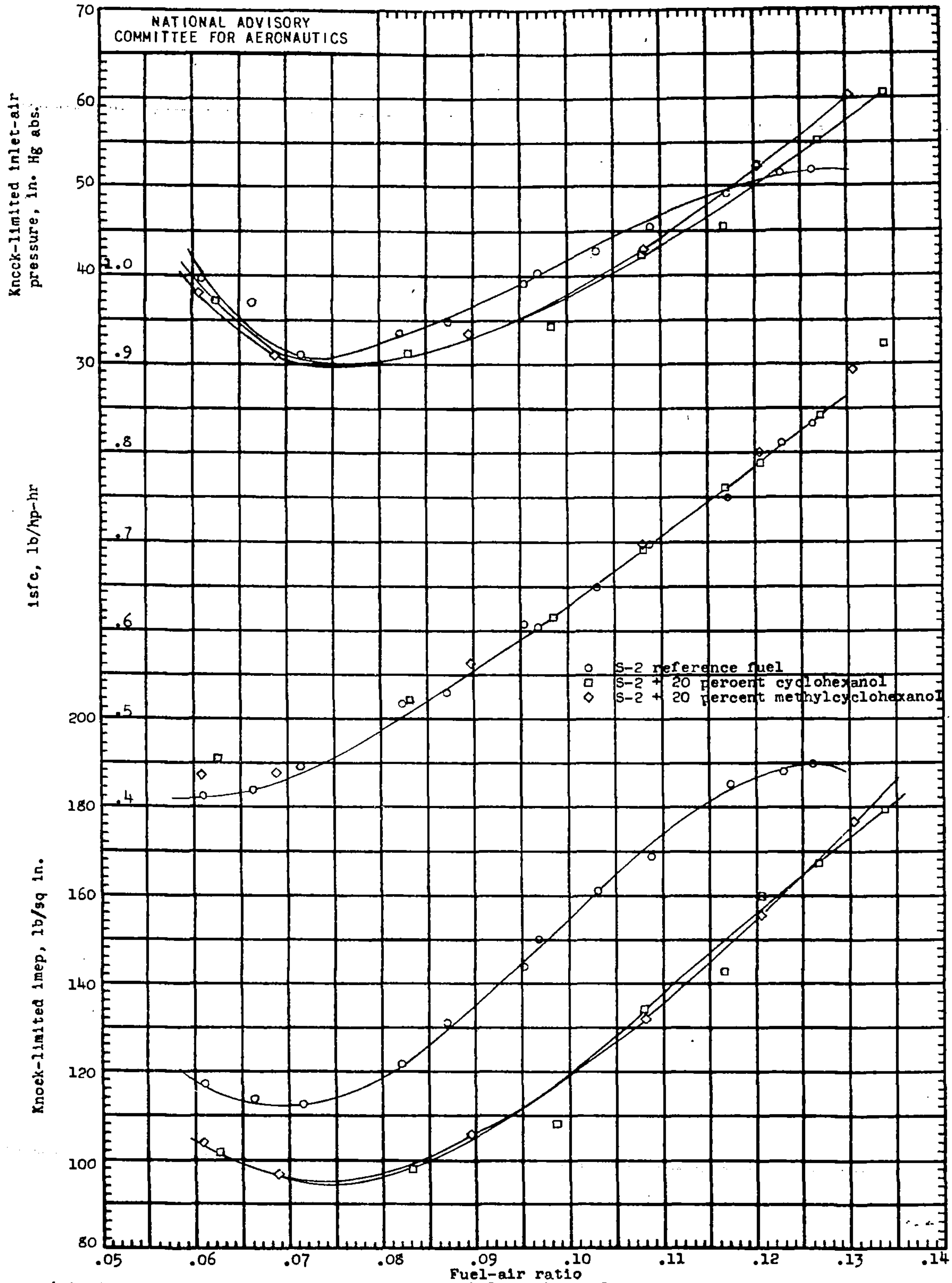
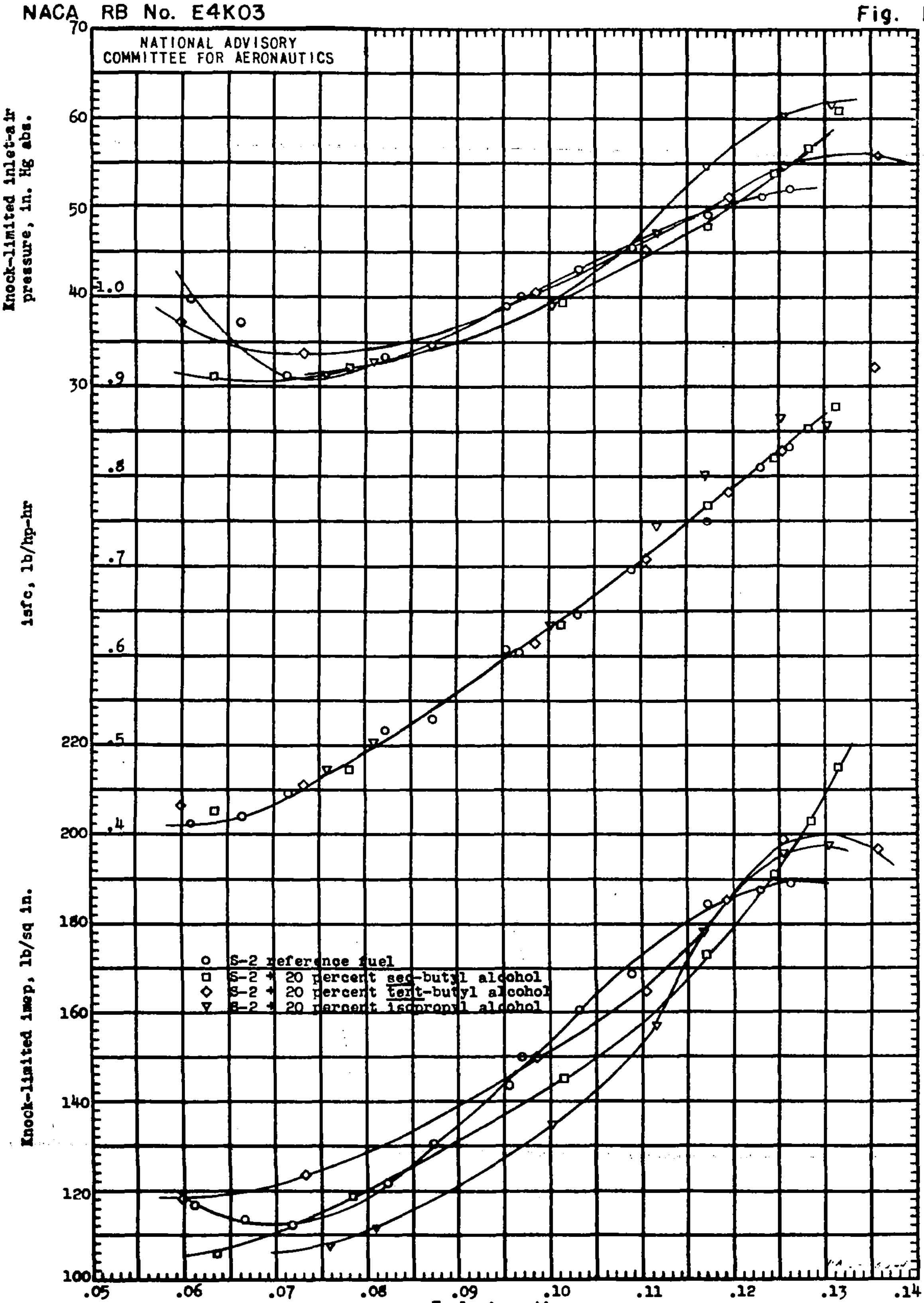
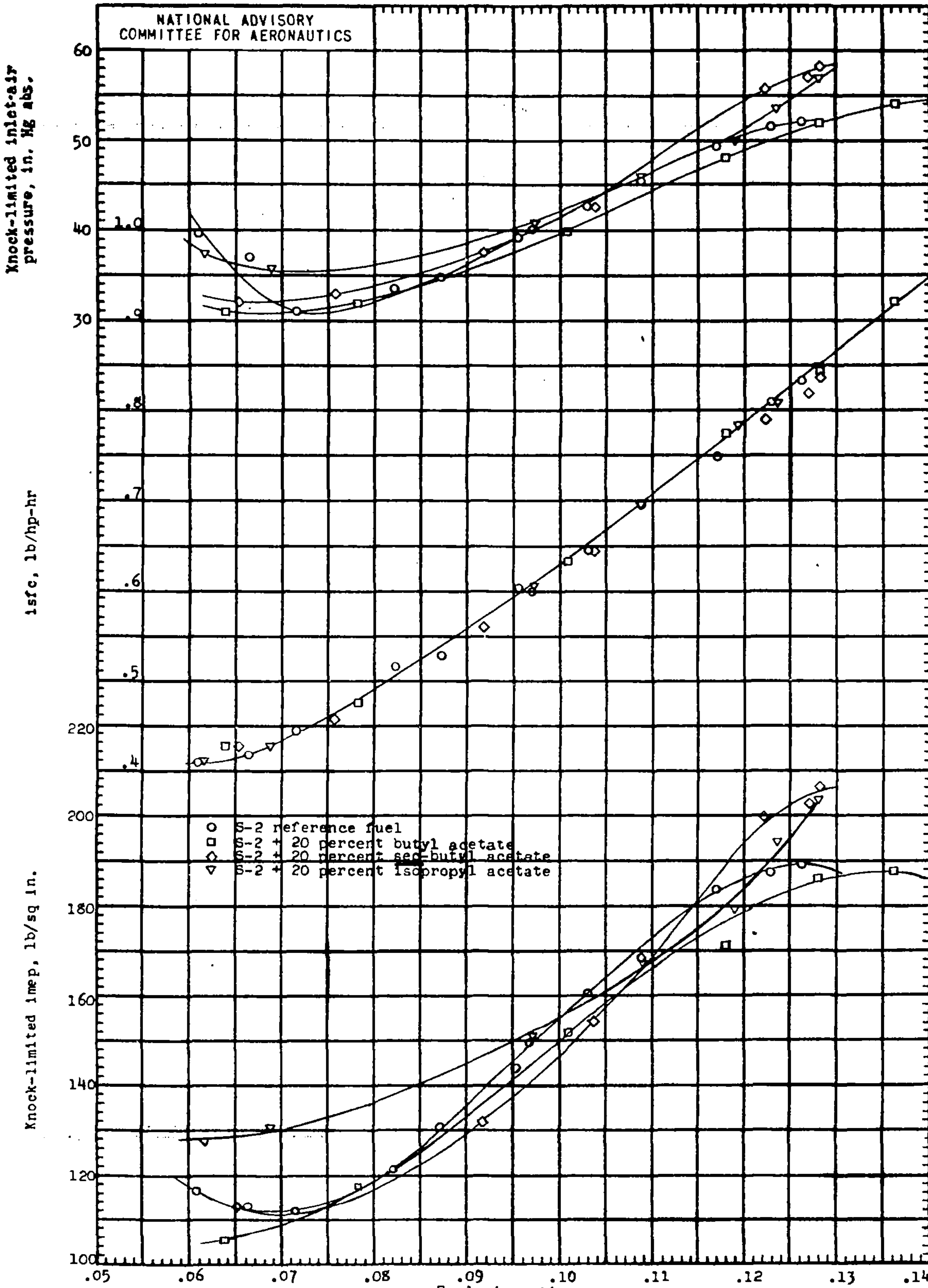


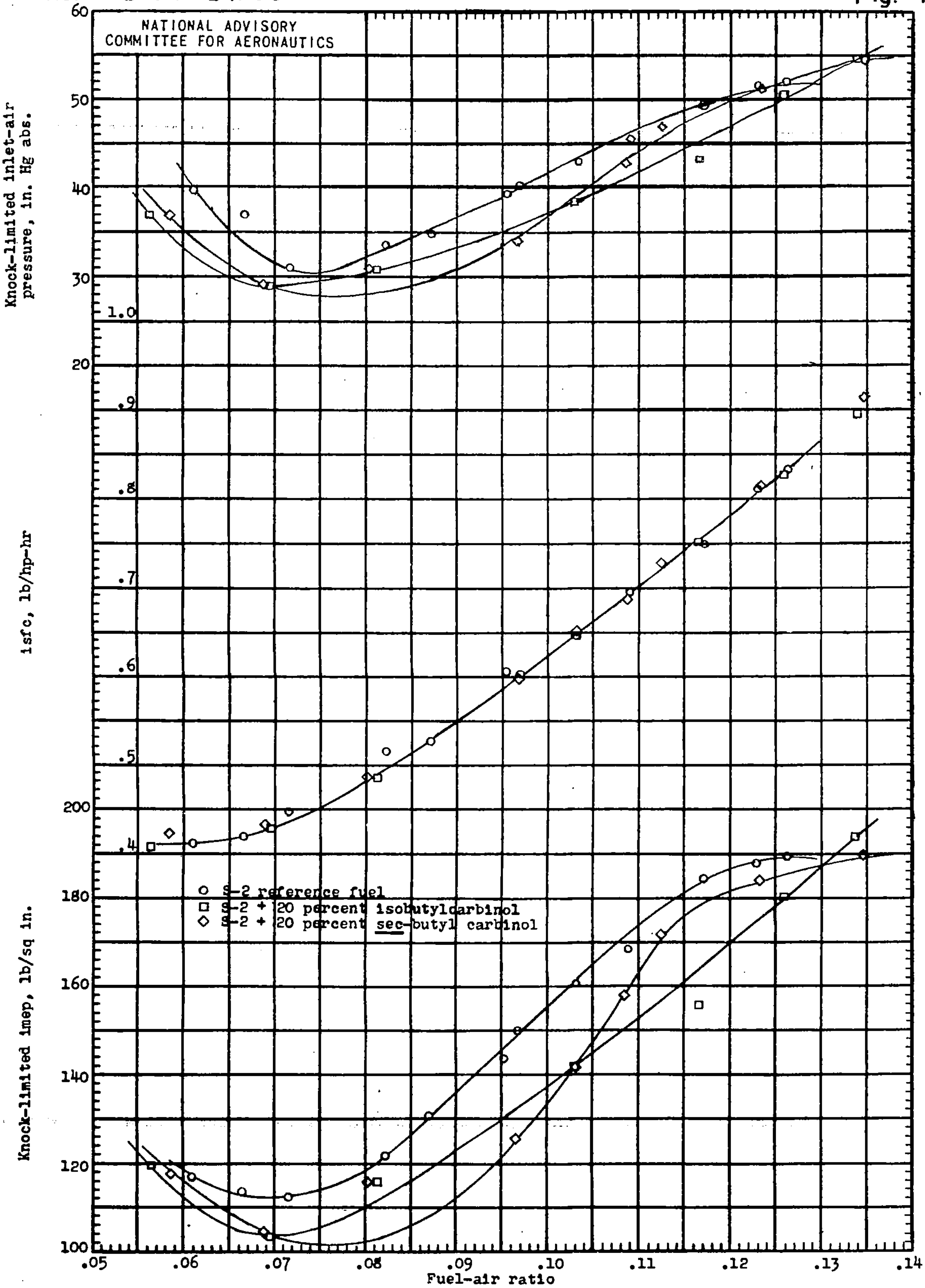
(a) Exploratory fuels, cyclohexanol and methylcyclohexanol.
Figure 1. - The knock-limited performance of blends of 80 percent S-2 reference fuel and 20 percent exploratory fuel. CFR engine; compression ratio, 7.0; coolant temperature, 250° F; inlet-air temperature 250° F; spark advance, 20° B.T.C.; engine speed, 1800 rpm; oil temperature, 150° F.



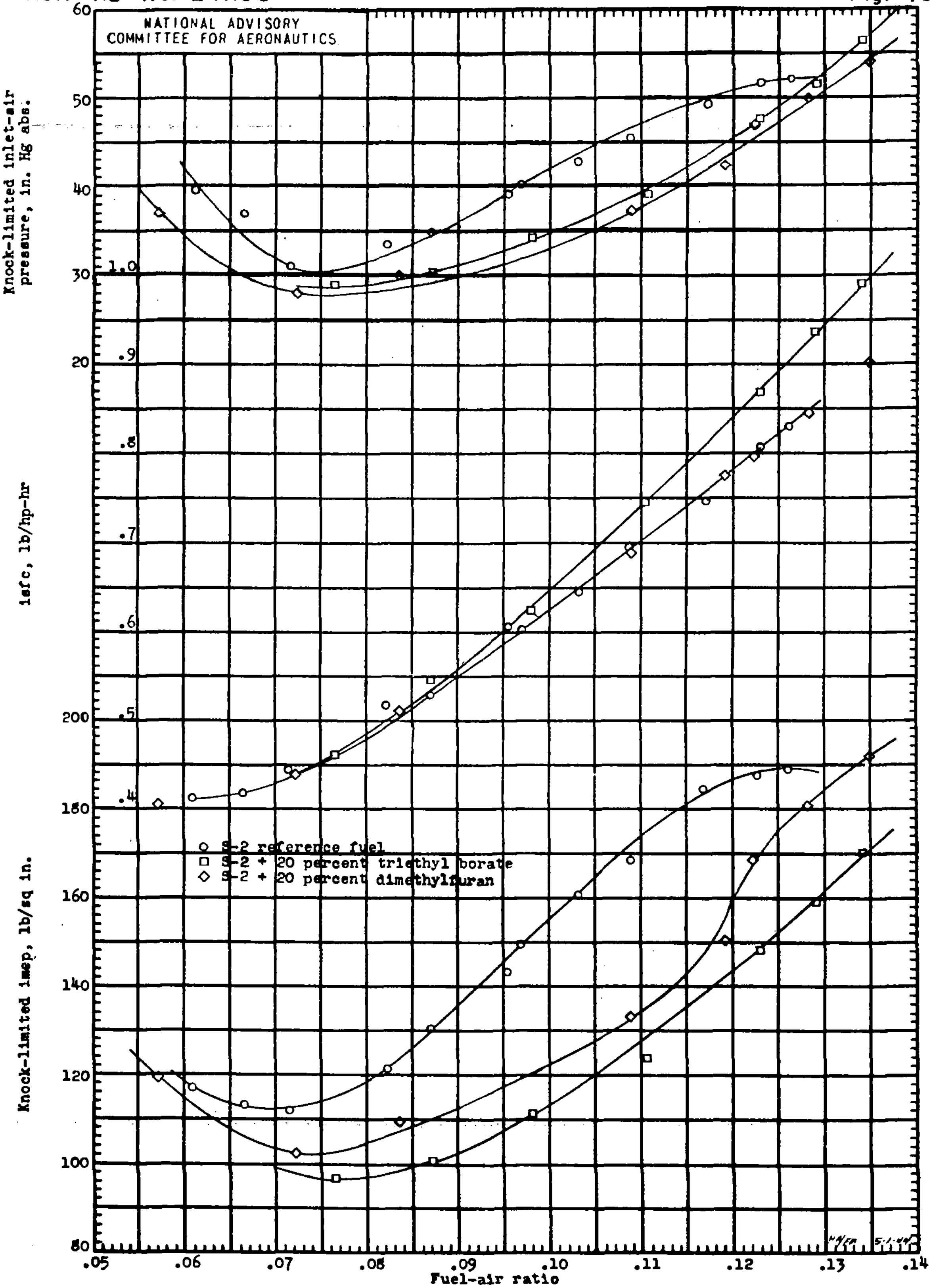
(b) Exploratory fuels, sec-butyl alcohol, tert-butyl alcohol and isopropyl alcohol.
Figure 1. - Continued.



(c) Exploratory fuels, butyl acetate, sec-butyl acetate and isopropyl acetate.
Figure 1. - Continued.



(d) Exploratory fuels, isobutyl carbinol and sec-butyl carbinol.
Figure 1. - Continued.



(e) Exploratory fuels, triethyl borate, and dimethylfuran.
Figure 1. - Concluded.

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ABSTRACT

Added to S-2 fuel, isopropyl ecetete raiees the knock-limited power moet effectively near the etoichiometric mixture retio. At 0.10 to 0.12 fuel/eir retio, it causes to improvement. Tertiery butyl alcohol is somewhat leee cepeble of improving knock-limited lean mixture performance. Secondary butyl and ieopropyl ecetetes and alcohole are only elightly effective in the very rich-mixture region. Triethyl borate end isopropyl alcohol improve the indiceted specific fuel coneumption quite subetantielly.

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